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OUTLINE FOR A SIMULATION STUDY OF THE CALIFORNIA STATE LIBRARY NETWORK

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Part 5 of the Final Report on

Specifications of a Mechanized
Center for Information Services
For a Public Library Reference Center

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ABSTRACT

An outline is presented for a digital computer simulation model for an information network for the State of California. The methodology of simulation is discussed initially. The problems presented by the very large size of the system, in terms of materials, users, communication connections are depicted, and solutions are suggested which permit more efficient handling of them. A scheme is discussed for representing the human element in this essentially man-machine system.

Methods are discussed for representing the effects of file organization, both for machine-readable data and for conventional materials of the libraries.

1. INTRODUCTION

METHODOLOGY OF SIMULATION

Systems analysis involves a segregation or isolation of the components of a system, followed by a second phase in which the original parts or variants of them are reorganized into alternative (new), integrated systems. The effects of the parts upon the whole are systematically reviewed in this process. When such a systematic approach is used and when relationships are presented with precision, in a quantitative fashion, much of the vagueness, ambiguity, and poor definition of the situation disappears. Thus, systems analysis depends heavily on quantification, measurement and conciseness of thought (often achieved through use of diagrams and flow charts).

Quantification often gives rise to the need for digital computer simulation, especially when the systems are large, when complex decision rules are employed, and when random processes are involved. For example, simulation models to aid in solving problems of equipment design, utilization of personnel, maintenance of equipment scheduling production, assigning storage in warehouses, and controlling product flow are common in the literature.

LIBRARY NETWORK SIMULATION

A library network presents comparable possibilities for analysis, since it embodies issues related to equipment (such as the design of facilities), to personnel, to the development of software and the monitoring of system performance, to the maintenance of computer files, to scheduling

of service, to the use of depositories for library materials, and to the flow of information. Special attention should be paid to the fact that libraries are on the threshold of a whole new era of mechanical and electronic services, which makes it especially important that the system be studied as a whole. This does not lessen the importance of models of components or subsystems, since precise data can be collected only on small portions of the system in any given study. Furthermore, not all networks will have exactly the same components; for those that do, some comparative studies can be performed. Component models and the total system model work hand-in-hand since the component models can be exercised to produce data for a large-scale or total system model. Exercising the sub-system models independently and using the results in the larger model streamlines the model for the latter case.

2. INFORMATION NETWORKS AS COMPLEX SYSTEMS

The major contributions to the complexity of information networks are those due to the "size" problem and those due to the fact that it is a man-machine system.

COMPLEXITIES DUE TO SIZE

The complexities of the information network described in other portions of this five-part report are illustrated in a variety of ways. The first and perhaps most striking illustration is the matter of size. The size of the "file" (i.e., the sum total of the data recorded in books and other materials) is enormous. The number of patrons of the library is large. Description of the system's operations (e.g., the geographical pattern of request input, the ways requests enter the system, the manner in which the "answer" to the request accumulates, the deliver of the results) requires such detail as to constitute another dimension of largeness.

COMPLEXITIES DUE TO THE HUMAN ELEMENT IN THE SYSTEM

The fact that the information system is a man-machine system introduces the necessity for accounting for many of the vagaries of human behavior. Included in the models must be aspects relating to the generation of needs, the determination of the alternatives most likely to meet the need, the response and reaction to total and partial success and failure in search. Later embellishments of the model will include aspects of information discovery and use.

3. REDUCTION OF THE PROBLEM OF SIZE

The problem of size that we have just outlined can be reduced by use of a set of classifications for various aspects of the system: classification of the user, the material items, and the services.

CLASSIFICATION OF USERS

The total number of users of the library system is so large that we cannot economically trace each user. Therefore, we propose to aggregate users by class of industry. Certain parameters associated with the users in the model must then be regarded as averages over individual users. This does not preclude us from maintaining one of the most attractive features of the model--the interaction of the user with the system.

CLASSIFICATION OF MATERIAL ITEMS

It is virtually impossible to deal with individual items in all the libraries, since there are millions of them. Our approach to this problem is to devise a classification based on recognized subject areas. A subject division can be built upon the areas of information required by different types of industry. Our procedure from this point is to specify or estimate the probabilities of finding individual bits or pieces of factual information, acquiring book materials, journal articles, bibliographies, etc. in each of the fields at each network library. This has the experimental implication that each Reference and Specialty Center in the network must be surveyed as to strengths and weaknesses in each of the areas.

The task of describing the availability of materials is somewhat more subtle than mere elaboration of strengths and weaknesses of holdings in certain areas of knowledge. Matters of policy are involved. For example, a medical library is, in general, much more capable of answering a question about medicine than is either a library of another Specialty or a Reference Center. However, the medical Specialty Center would probably not want to become involved in every public question involving medicine. It would probably wish to restrict services to qualified research personnel, hospital staffs, and, perhaps, medical school students.

CLASSIFICATION OF SERVICES

In the State of California there are approximately 160 formally recognized libraries with over 1,600 points of access. Over a period of a single year millions of requests for information, including single factual inquiries, questions concerning the availability of materials, requests for bibliographic listings, etc., are processed in the state. We shall classify each request as being one of essentially four types: a factual inquiry, a request for a single material, a survey of materials, or an exhaustive search for materials.

We may also classify requests according to the point at which they are satisfied: (1) at the point of access, (2) at the library to which the point of access belongs, (3) at a library within the Specialty or Reference Group, (4) at the Specialty or Reference Center, (5) at the Switching Center. Most needs are met either at the point of access or by the library organization with which the access point is affiliated. As such, the communications problems, the searching endeavor, the relaying of materials that occur are at a low level and do not call into play the essential ingredients appropriate to the network denotation. Consequently, we may wish to concentrate our attention on requests in class three, four, and fiv .

The fact that the overwhelming majority of requests are satisfied at the point of entry into the network is to some extent due to the fact that the user gets to know where information of a given type can be found and therefore presents his requests at such a point and so in the process maximizes the probability of successful response to his queries at the original entry point. Often this takes place at the expense of great personal inconvenience for the user and hopefully the advent of information networks will help put an end to this form of inconvenience.

4. USER BEHAVIOR

Developing a model for the behavior of the user presents problems for which the methods developed by mathematical psychologists provide guidelines. The central questions are the development of needs in time, the decisions the user makes to decide whether the information network can meet his needs, and the user's reaction to system response.

DEVELOPMENT OF NEEDS IN TIME

The time development of needs in the model is regarded as independent of other considerations. The assumption is that, over the period of time represented in the simulation model, the user's behavior may be changed but not in the area of need development.

TENDENCY TOWARD UTILIZATION OF THE LIBRARY SYSTEM

Given that a need for information has been developed, it can be met via a variety of sources: from a colleague, from a reference work, from a library. A set of probability values covering each of these alternatives can be built into the model although in most cases it is sufficient to divide all needs for information into two classes: those which the user thinks the library can meet and those which the user thinks it cannot or should not be called upon to meet. When we do this, we need only a single probability representing a threshold value for coming into the library. We allow this parameter to be altered by the experience of the user; what we have here effectively is a "learning" model for the user, an adaptive component in the system.

ESTIMATION OF THE SERVICE TIME

The view of the user presented above is not complete without another process in which the user makes a subjective estimate of the amount of time it will take to meet his need for information and compares that with the time within which, according to assignment or according to proclivity, he must have the information. The decision to go or not to go into the library depends upon the result of the comparison. We also allow the parameters of estimation here to change as a function of the user's experience so that an adaptive component is once again included in the model.

The model as described provides a basis for experimental study of library users. It suggests that specific data be collected. Data collection in turn may affect the further development of the simulation model since further refinements may come to the attention of the experimenter. This interaction of data with the model and vice versa is at the heart of the simulation method.

An exceedingly important implication of the adaptive aspect in the model is that better service implies more use of the library. Anticipation of changes in user behavior and (consequently) demand on the library system is fundamental to sound planning.

5. PROCESSING OF REQUESTS WITHIN THE NETWORK

Despite the confinement of attention to classes of users, materials, and services, the most essential ingredients of a true network (e.g., communication among remote points, searching a machine-readable file system, delivery of materials, etc.) still remain. The requests of concern to us are those emanating from the 160 main libraries of the state. Each of these libraries can be expected to be a member of a library group (e.g., the Regional and Specialty Center Groups described in other parts of the report). Each group has a Group Center. It is estimated that there will be approximately sixteen of these centers; nine of these are Regional or Reference centers and seven are Specialty centers.

PATHWAY OF REQUESTS IN THE SYSTEM

The environment associated with each Group Center consists of subordinate or member libraries, libraries at an equal level, and, of course, the Group Center's own patrons. Libraries such as the Specialty Libraries which are approached with more specific and detailed questions receive requests also from the Switching Center. If the requirements of the request cannot be met at the Group Center, it must be forwarded to some other center. Two alternatives of system design are available at this level. In the first case, the requests which cannot be handled by the center are forwarded to the Switching Center. The Switching Center, in this alternative, has the most complete set of files in the state and can determine where any material

is or where any question has highest probability of being answered. The Switching Center also might have telephone connections with each of the libraries and thus can communicate person-to-person, if necessary, with each library in the network.

In the second alternative, each center library is directly connected to all or a substantial number of the other center libraries. In this case, requests usually move about over a teletype communications system. Only when requests cannot be handled in this way are they then referred to the Switching Center, the major responsibility of which is to maintain contacts with national Major Resources. A medical network in the southeastern United States provides us with an example of a group of cooperating libraries in which the search strategy is similar to this second alternative. A request is generated and sent to the nearest library. That library determines on the same day whether or not it has the resources to satisfy the request. If the request can be met, the materials are sent out in the mail and will arrive the following day. If the request cannot be met, a message to that effect is conveyed to the original library. The library of origination then approaches a second library in the network. This strategy of search is quite time consuming and yet it has been found to be an extraordinary improvement over previous service. As a result, the number of requests previously forwarded to the National Library of Medicine has decreased by approximately 34% so that more requests are being satisfied at the local library level. Less of a load is being put on the National Library of Medicine.

Within the scope of each of these main-line alternatives, as is apparent, are a number of sub-alternatives: the mode of communications, when during the day such communications are permitted, when searches are

performed, the manner in which success or failure is relayed to the requestor. The model is used to assess the relative merits of these alternatives.

TIME DELAYS IN HANDLING REQUESTS

At various points along its pathway through the system the request experiences a time delay. Accumulation of all the delays along the path constitutes the actual service time. There are at least two important aspects of delays that should be analysed: the effect of the priority system upon the services to certain classes of users; the effect of organization of the file, including both the file of conventional materials and the machine-readable data base.

PRIORITIES ON REQUESTS

In a more fully automated system, the matter of priorities becomes a thorny problem. Priorities are not set on the basis of status of the users alone. Priorities also serve to overcome some of the complexities in operating a large and diversified organization. Examples of this type of priority are those associated with the point of origination of the request and the complexity of the request.

Point of Origination of the Request

Each library in the network has its own users to attend to. Depending on its level in the network it will also bear the responsibility for tending to the needs of other libraries. There will be a gradation of such a responsibility, with libraries which are members of the group having higher priority than other members of the network. Balance is to be obtained between attending to the needs of the library's own users and the needs of the member libraries of its group.

The Complexity of the Request

Requests will achieve priority according to their complexity (or more precisely according to their lack of complexity). A direct interrogation as to the whereabouts of a recently published material can be expected to be handled more quickly than can a request involving a survey of relatively rare and older materials. The division of the file according to age of the materials is necessitated by the limited storage capacity of (computer) peripheral devices.

Status of the Requestor

The status of the individual who makes the request will figure into the priority allocation. Already in university libraries a graduation in quality of service exists over the range from professional staff through graduate students down to lower division undergraduates. Technical libraries also provide best quality service to only a selected clientele.

FILE ORGANIZATION AND SEARCH STRATEGY

The "file" of the library network consists of machine-readable and conventional materials. The structure of these files and the allocation of resources to them, has a profound effect upon service time. Financial constraints play an important role in delimiting the quality of service in both areas.

Distribution of Conventional Materials

It is too costly for all libraries to have equal quality in service with conventional materials. Whether this is possible with microreproduction of materials depends upon a number of factors among which are cost (especially for the initial phase) and quality and quantity of viewing devices.

Distribution of Machine-Readable Files

Whether the data of the machine-readable file are to be widely dispersed or not depends on cost factors related to machinery and personnel availability. One of the alternatives discussed above envisions the Switching Center as having the most complete coverage of what materials are available in both the state and the nation. In this view the number of requests which would pour into the Switching Center would be very large. In the second view discussed above, the computer files would be more widely dispersed. The Switching Center would maintain files pertaining to national resources and at each Regional and Reference Center, files pertaining to materials available in its vicinity. Duplication of general interest material in the centers' files would be necessary and the extent of it would be an issue that the simulation model could help resolve.

Organization of the File for Computer Processing

Most currently operating machine information retrieval systems handle requests on a bulk or batch basis. Recently, a great deal of attention has been applied to on-line systems. The library network requires a system in which both modes of operation are incorporated. An example in the medical area is that of MEDLARS. Today requests are received at local MEDLARS centers, formulated in the terminology necessary for computer search and then forwarded to a national center where they are grouped (batched) and run against the file. The results of the search are mailed out. In a future system the user will still forward his request via telephone or mail. The formulation of the request, however, will be handled through on-line communication between the local MEDLARS experts. The request itself will be sent on to the national center for batch processing. The new mode of operation hopefully will remove a bottleneck that has developed at the local

MEDLARS centers and accordingly reduce response time. It will also be possible before final submission of a request for the local MEDLARS personnel to contact the individual user who developed the need for information and check with him on the formulation of the request.

The MEDLARS case is however far more simple than that of the library network. (The data base is very simple, one master file and its auxiliaries; in many other such environments total on-line operations including update as well as retrieval is being advocated.) The library network processing needs include a number of files similar to MEDLARS in purpose, but with little or no common formatting. Processing of textual files and statistical manipulation of numerical attribute files help make the problem even more complex. Since we are now dealing with a library-based system there is an interest in collecting data bases. A Parkinson Law type of effect can reasonably be predicted here, that is, the number and the size of the machine-readable file will grow until it is limited by available equipment (presuming that the financial support of the network is sufficiently high).

Evolution of the Organization of the Machine-Readable File

The bulk of the processing in the initial phase of network operation will be on a scheduled batch basis. Gradually, the batch-mode will become less depended upon, but will never be totally eclipsed. The information retrieval load is too heavy to handle on an on-demand basis. Furthermore, many requests require extensive paper output and otherwise present little time constraint, e.g., the request for a bibliographic listing. The batch mode of operation often implies tape-stored data, whereas the on-line implies a master and auxiliary files on direct access devices. The combination system seen for the future will bring into play a complex system of file organization. A likely prospect is an activity organized file in

which the most active portions of the file, usually the most current plus some items of high interest, are maintained in residence on the disks of the computer system whereas less utilized portions of the file are on removable disk packs or on tape. The simulation model will be used to study the development of this system as it moves from a batch processor system to a more complex activity-organized file system. It may also contribute to the establishment of an automatic system for achieving the activity organization procedure.

Another fact of compromise between the extremes of on-line and batch modes of operation still related to activity organization is the possibility of an intermediate state of small batch processing. Just as batch implies a different organization from on-line, so also does small batch processing imply still another form of file structure. Small batch processing implies indexes to master files. The master files (and there are several of these in each center) usually are composed of several tapes and when a batch consisting of a small number of requests is presented only a few of the tapes in the collection need be addressed. A mode of operation involving indexes on disk and master files on tape might be well suited to this need.